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instrumentation and software for research

VARIABLE SPEED INFUSION PUMP

WITH SERIAL CONTROL

PHM-100VSS

USER'S MANUAL

DOC-001
Rev. 3.5

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notes

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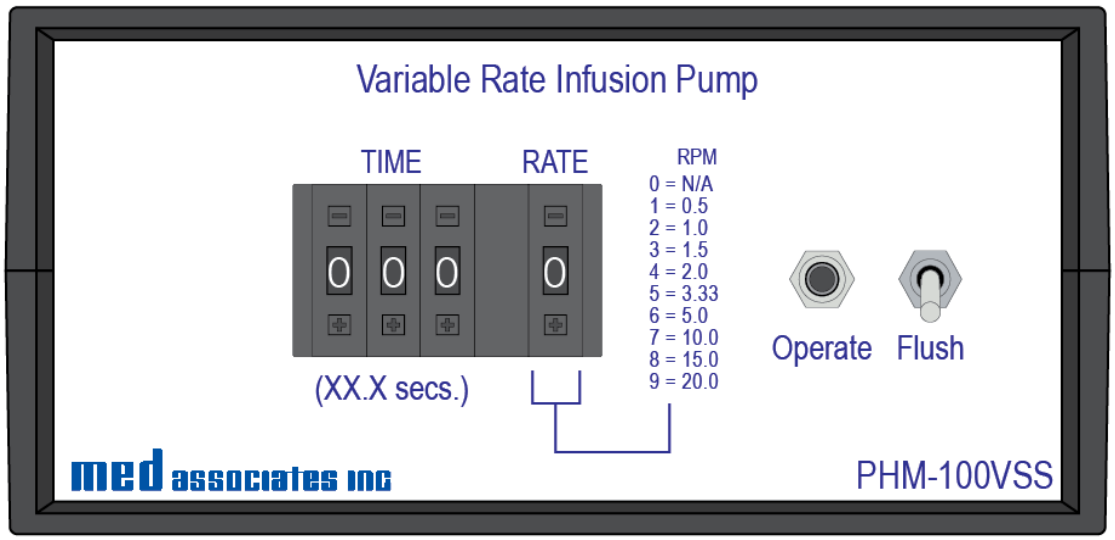
CHAPTER 1 | INTRODUCTION

The PHM-100VSS provides infusions from 0.1 to 99.9 seconds at rates ranging from 0.5 to 20 RPM. The unit can be operated using a MED interface output bit, a TTL control line, a switch closure, MED-PC, or a computer with the serial control.

The PHM-100VSS requires 110 volts, 60 cycle AC. Use part number PHM-100VSSA for 220 volt, 50 cycle applications. The PHM-100VSS requires a DIG-729 High Speed Serial controller card in the operating computer if used with MED-PC.

Figure 1-1 – PHM-100VSS Front View



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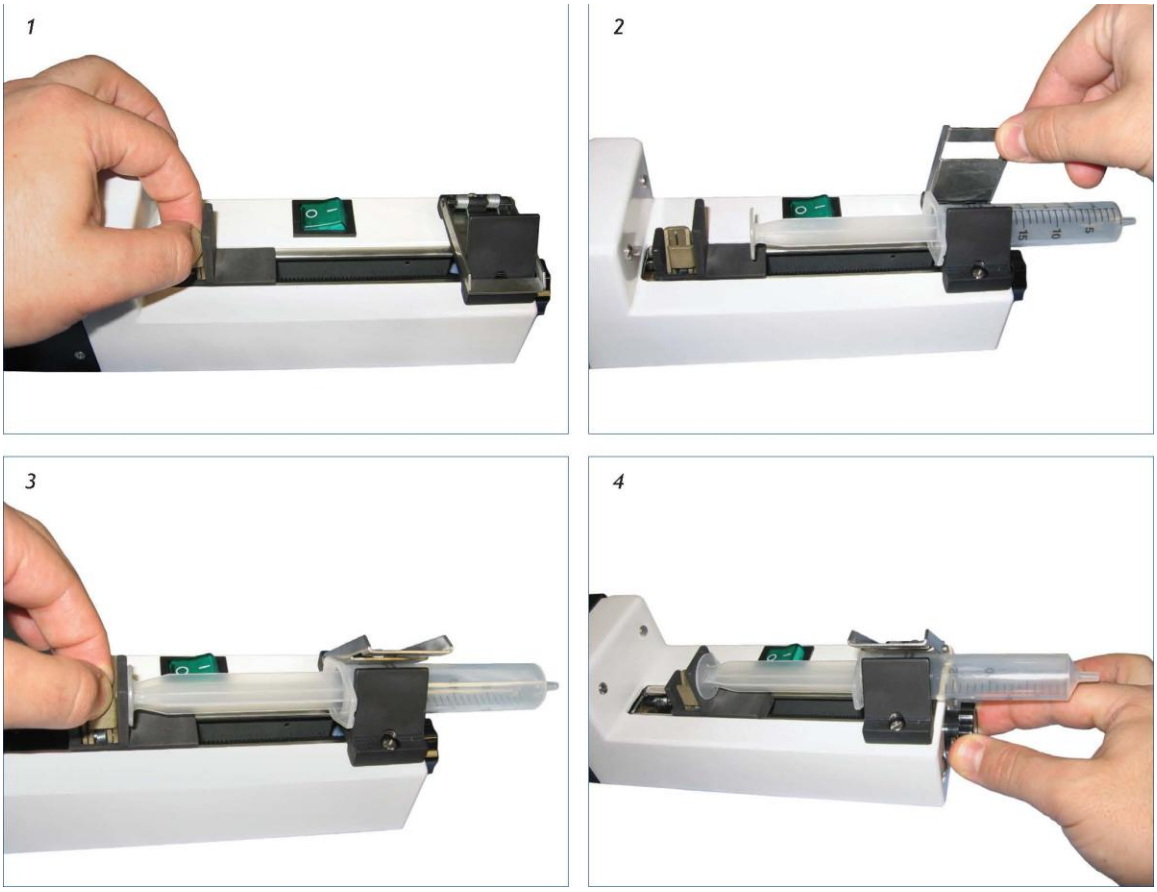
CHAPTER 2 | SYRINGE PLACEMENT

Care should be exercised to ensure that the hub of the syringe barrel is positioned adjacent to the syringe clamp when loading the syringe pump. If a gap exists between the hub and the clamp, accurate flow rates cannot be assured, as the entire syringe (both barrel and plunger) may move forward. A visual check by observing the plunger move in relation to the barrel by rotating the front knob of the pump is advised. Figure 2-1 illustrates the procedure for loading a syringe into the pump.

Figure 2-1 - Loading a Syringe



1. Move the slide to rear (toward motor section) by squeezing the jaws.
2. Insert syringe by lifting clamp cover and placing the syringe body into the clamp.
3. Move the slide to the end of the syringe.
4. Rotate the knob so that the slide makes contact with the plunger and the syringe contacts the clamp.

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Priming the Line

Once the syringe is installed, the line should be primed until liquid drips out of the syringe or tubing. This ensures that fluid will be infused properly when the pump is activated.

Prime the line by setting the **Flush** switch in the "down" position for as long as required. The settings of the **TIME** and **RATE** switches are not recognized when the **Flush** switch is on; the pump will operate at 10 RPM and will only operate when a timed infusion is not in progress.

Glass Syringes

Extra caution should be exercised when using glass syringes with a ground glass plunger. These syringes exhibit almost no sliding friction and thus can cause an uncontrolled infusion in the following two ways:

1. The weight of the plunger may be sufficient to push the fluid out of the syringe if the syringe is held with the plunger above the syringe.
2. The weight of the fluid in the tubing may be sufficient to siphon the fluid out of the syringe if the catheter infusion site is below the height of the syringe.
3. To test for these two conditions, it is suggested that the syringe be connected to the tubing and held vertically at the height of the pump. If no motion occurs, the syringe can then be placed in the pump.

The following may reduce the danger of an uncontrolled infusion:

1. Lower the relative height of the infusion pump in relation to the infusion site. With the pump below the infusion site, the instrument will pump the fluid to the higher elevation.
2. Use a smaller bore catheter, which will reduce the weight of the fluid in the tubing and increase the friction on the flowing fluid.
3. Position the pump so that the syringe is vertical (plunger below), thus the weight of the syringe plunger will be acting against the weight of the fluid.

Use a syringe with a rubber seal on the plunger, i.e. an O-ring sealed or plastic syringe.

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CHAPTER 3 | CONTROLLING THE PUMP IN MANUAL MODE

The following control options can be used to control the pump when the MODE switch is in the **Manual** position, as shown in Figure 3-1. The settings of the **TIME** and **RATE** switches will determine the duration and rate of the infusion when operating in Manual mode. If the end of the syringe is reached during an infusion the Automatic Shut-Off Switch will be activated and the infusion will be stopped. Refer to the **Automatic Shut-Off Switch Adjustment** section of this manual for further information.

Figure 3-1 - Back Panel of the PHM-100VSS

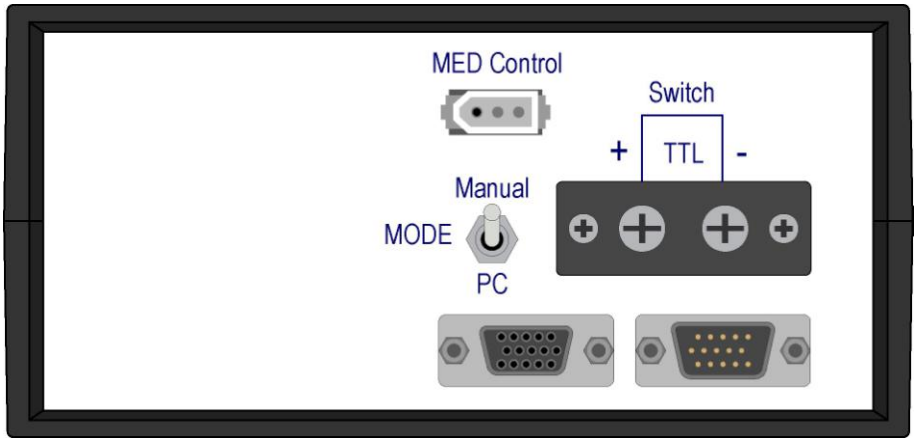
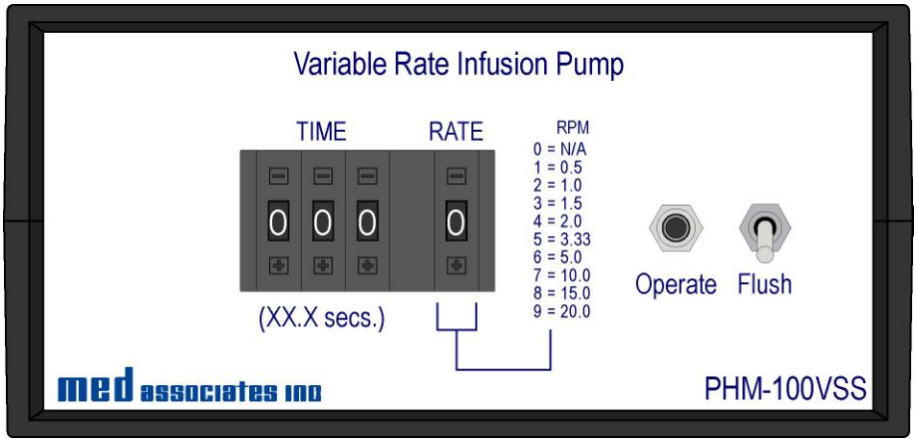


Figure 3-2 - Front Panel of the PHM-100VSS



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Setting the TIME and RATE Switches

The duration and speed of the infusion are set using the **TIME** and **RATE** pushbutton switches on the front of the PHM-100VSS. The **TIME** switches are used to set infusion times from 00.0 to 99.9 seconds, and the **RATE** switch is used to select the pump RPMs, as indicated by the table on the pump, and also shown in Table 3.1.

For example, a **RATE** pushbutton switch setting of 2 would produce a speed of 1.0 RPM. Note that 0 is not used and has no effect. In the example shown in Figure 3-3, the infusion time has been set to 35.0 seconds and the rate is set to 2.0 RPM.

If the end of the syringe is reached during an infusion the Automatic Shut-Off Switch will be activated and the infusion will be stopped. Refer to the **Automatic Shut-Off Switch Adjustment** section of this manual for further information.

Figure 3-3 - Example Settings

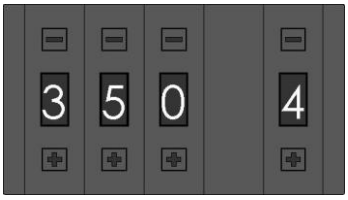

Table 3.1 - RATE Pushbutton Switch Settings

RATE Pushbutton Setting	Corresponding RPMs
0	N/A
1	0.5
2	1.0
3	1.5
4	2.0
5	3.33
6	5.0
7	10.0
8	15.0
9	20.0

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Flow Rates and Pump Speeds

The following table shows the flow rates in milliliters per minute of several commonly used syringes.

Thumbwheel Setting	Motor RPM	1 mL Multifit	2 mL Multifit	5 mL Multifit	10 mL Plastipak	10 mL Multifit	12 mL Monoject	20 mL Plastipak	20 mL Multifit	20 mL Monoject	30 mL Plastipak	30 mL Multifit	35 mL Monoject	50-60 mL Plastipak Monoject	50 mL Multifit
1	0.50	0.017	0.061	0.106	0.160	0.165	0.193	0.278	0.295	0.323	0.358	0.395	0.437	0.542	0.603
2	1.00	0.034	0.122	0.212	0.320	0.331	0.386	0.557	0.589	0.646	0.715	0.791	0.874	1.084	1.206
3	1.50	0.052	0.184	0.318	0.480	0.496	0.579	0.835	0.884	0.969	1.073	1.186	1.311	1.626	1.809
4	2.00	0.069	0.245	0.424	0.640	0.661	0.773	1.114	1.179	1.292	1.431	1.581	1.748	2.169	2.412
5	3.33	0.115	0.408	0.706	1.066	1.102	1.288	1.856	1.965	2.154	2.385	2.636	2.914	3.614	4.02
6	5.00	0.172	0.612	1.059	1.600	1.653	1.931	2.784	2.947	3.231	3.577	3.954	4.371	5.421	6.031
7	10.00	0.344	1.223	2.118	3.198	3.306	3.863	5.895	5.895	6.462	7.155	7.907	8.741	10.843	12.061
8	15.00	0.516	1.835	3.177	4.798	4.959	5.794	8.353	8.843	9.694	10.732	11.861	13.112	16.264	18.092
9	20.00	0.688	2.446	4.236	6.397	6.612	7.726	11.137	11.789	12.925	14.310	15.814	17.483	21.686	24.122

To calculate the flow rate of a syringe not given above, use the following formula:

Flow Rate (mL/min) = 0.19538 * RPM * syringe cross-sectional area

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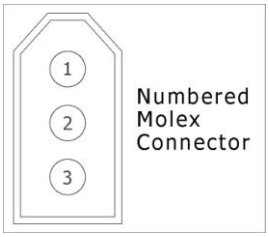
MED Control

Connect the **MED Control** connector shown in Figure 3-1 to any available output on a Standard MED Connection Panel using a standard Molex cable. The pinout of the 3-pin Molex connector is shown in Figure 3-4. Upon receiving an operate signal, the pump will begin the infusion the settings of the **TIME** and **RATE** switches on the front panel, and then it will stop. The operate signal must be toggled off between infusions. Any changes made to the **TIME** and **RATE** settings during an infusion will not be acknowledged.

Figure 3-4 - MED Control Connector Pinout

Molex Pin #	Function
1	Not Used
2	+28 Volts
3	Operate



TTL Control (5V)

Connect the TTL ground to the (-) screw terminal and the TTL operate signal to the (+) screw terminal. A TTL high to low transition on the operate line activates the pump.

CAUTION: Voltage levels above 5.2 VDC at the TTL terminals can damage the unit.

Switch Closure Control

Simply connect a switch between the (+) and (-) screw terminals. Closing the switch will operate the pump. The switch must be opened and closed again to activate the pump for another cycle.

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CHAPTER 4 | CONTROLLING THE PUMP IN PC MODE

The supplied software allows the pump to be controlled using MED Test program or MED-PC when the MODE switch is in the **PC** position. The settings of the **TIME** and **RATE** switches are not recognized when operating in PC mode. If the end of the syringe is reached during an infusion the Automatic Shut-Off Switch will be activated and the infusion will be stopped. Refer to the **Automatic Shut-Off Switch Adjustment** section of this manual for further information.

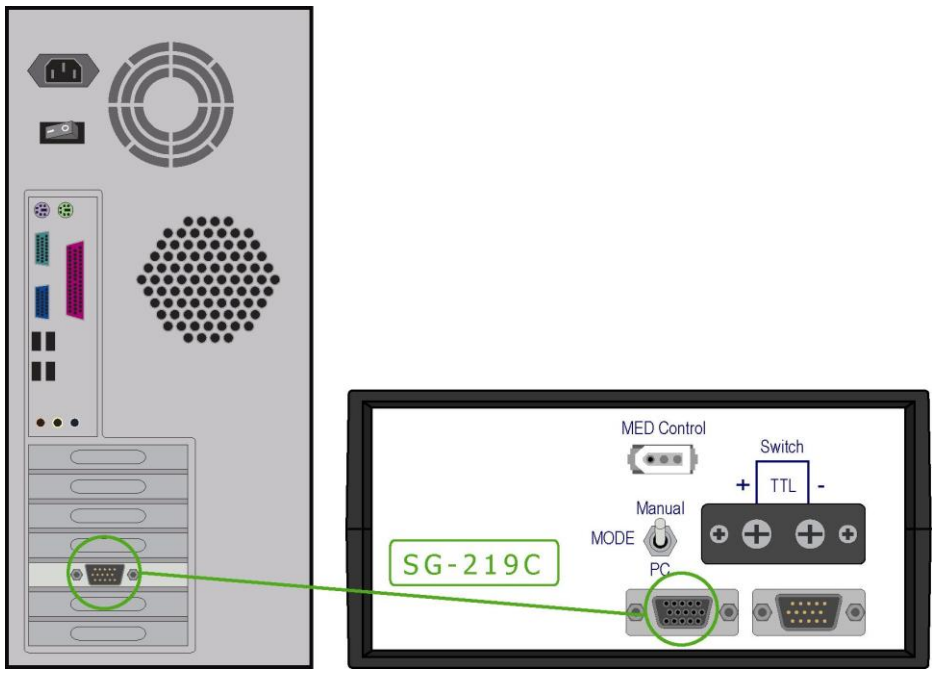
DIG-729 Installation

Consult the "DIG-729 High Speed Serial Controller Installation Guide" (MED Associates Part Number DOC-002) for instructions on installing the DIG-729 card.

Wiring Instructions

Connect the female DB-15 port on the back panel of the PHM-100VSS to the DIG-729 card in the PC using the SG-219C cable provided.

Figure 4-1 – Connect Female DB-15 to DIG-729 Card



Connect the PHM-100VSS power cord to a standard wall outlet and power on using the lighted ON/OFF switch.

To control additional PHM-100VSS pumps, connect them in daisy-chain fashion by connecting the male DB-15 port on the first pump the female DB-15 port on the second pump using an SG-219C cable. Up to 16 pumps may be daisy chained together in this fashion.

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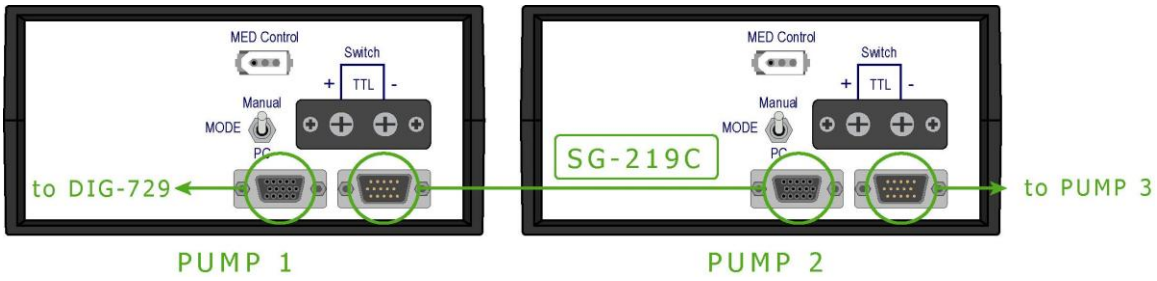
Figure 4-2 – Controlling Additional Pumps



NOTE: The length of the SG-219C cables used to connect the pumps should not exceed 10-feet.

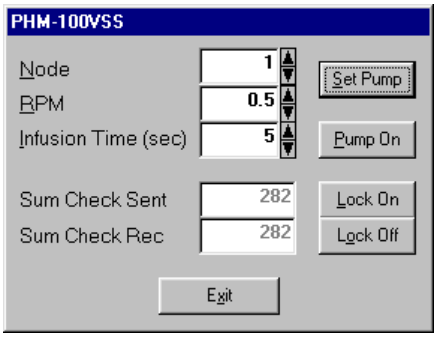
PHM-100VSS node numbers are factory set and should be clearly labeled on the pump case. The units can be daisy-chained in any order; however, the last unit in a series must have the highest node number and must have the terminate switches ON. In most cases, users will not need to adjust the network address or terminate settings on the PHM-100VSS pump. However, if a new PHM-100VSS pump is being added to an existing daisy-chain network, the network address and terminate settings of the PHM-100VSS pumps may need to be reset. See Appendix A for details on changing network addresses and terminate settings on the PHM-100VSS pump.

Controlling the Pump Using MED Test

The MED Test software allows the user to test the PHM-100VSS pumps. MED Test is included on the MED-PC software CD. If an updated version of MED Test is needed, please contact MED Associates for instructions on how to get the latest version.

Open MED Test and select **Pumps** | **PHM-100VSS** to open the Test Screen.

Figure 4-3 - MED Test Screen



Enter the node number (the pump should be labeled with this number), the desired rate (RPM), and Infusion Time in seconds. Once these values are entered, click **Set Pump** to start the PHM-100VSS pump. After the data is sent to the pump the pump's status is displayed in the Sum

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Check Sent and Sum Check Rec fields. The two fields should match. If a pump is not responding, check that the power is on and all network connections have been properly made. If necessary, contact MED Associates for further assistance.

Once the correct data has been entered and the pump is responding, the pump can be turned on by clicking the **Pump On** button. A pump may be operated repeatedly with the same data by repeatedly clicking the Pump On button.

Controlling the Pump Using the Included MED-State Notation

To control the pump using the program that is included on the PHM-100VSS CD, insert the CD into the CD-ROM drive and click **To Install the PHM-100VSS Software**. The procedure is copied into the installation directory.

Programs written in MedState Notation must be translated using Trans IV before they can be executed in this application. Open Trans IV icon and select **Translation** | **Translate and Compile**.

Select the program(s) to use and click **Make**. Click **OK** to start the translator, and it will automatically parse the MedState Notation and then open to a DOS screen to compile the Pascal code. Depending on the speed of the computer, each of these steps may not be seen.

Open MED-PC and the MED-PC Experiment Loading Wizard's Welcome screen will appear. Follow the steps to load the program, issue a START command or the desired K-pulse by selecting to **Configure** | **Signals**.

```
\ Copyright (C) 2008 MED Associates, All rights reserved.

\ PHM100VSS.MPC
\ This program demonstrates how to properly call the MED-PC commands that Start
\ and Stop the PHM-100VSS Pump.
\
\ The BOX parameter specifies which PHM-100VSS Pump to start.  When this program
\ is running in Box 1, then the BOX parameter will equal 1 and Pump 1 will
\ start.  When this program is running in Box 2, then the BOX parameter will
\ equal 2 and Pump 2 will start, etc.  This allows the same program to be run in
\ multiple Boxes and control different Pumps.

\ A() = Control Variables with Assigned Aliases as Defined
Var_Alias Duration (0.1 - 99.9 seconds) = D  \ Default = 10 seconds
Var_Alias Rate (0.5 - 20.0 RPM)         = R  \ Default = 1 Revolution Per Minute

\ List Working Variables Here
\  E = Infusion Duration in MED Ticks

\ K-Pulses Used in this Program
\  K1 = Turn on the Pump at the currently set Rate and then increase the Rate by 1
\  K2 = Turn on the Pump at the currently set Rate and then decrease the Rate by 1
\  K3 = Lock on the Pump at the currently set Rate
\  K4 = Turn off the Pump

S.S.1,
S1,
  0.001": SET D = 10, R = 1 ---> S2

S2,
  #START: ---> S3
  1": SHOW 1,Duration,D, 2,Rate,R ---> S2
```


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```
S3,     \ Send the values down to the Pump
  0.01": ~SetPump(MG, BOX, R, D);~;
         SHOW 1,Duration,D, 2,Rate,R, 3,Pump Off,0;
         SET E = D * 1" ---> S4

S4,     \ Wait for command to turn the Pump on
  #K1: ~OnPump(MG, BOX);~; SET R = R + 1;
       SHOW 3,Pump On,1 ---> S5
  #K2: ~OnPump(MG, BOX);~; SET R = R - 1;
       SHOW 3,Pump On,1 ---> S5
  #K3: ~LockOnPump(MG, BOX);~;
       SHOW 3,Pump On,1 ---> S6

S5,     \ Make sure the User can't send another OnPump
        \ command while the Pump is running.
  E#T: IF R > 20 [@True, @False]
         @True: SET R = 20 ---> S3
         @False: IF R < 1 [@True, @False]
                    @True: SET R = 1 ---> S3
                    @False: ---> S3

S6,     \ Turn the Pump off
 #K4: ~LockOffPump(MG, BOX);~ ---> S3
```

Controlling the Pump Using Custom MED-State Notation

The PHM-100VSS can be controlled using the included MED-State Notation procedure (PHM-100VSS.mpc), or a custom procedure can be created using the following commands.

SetPump

The SETPUMP command sets all pump parameters to be the same as the specified pump and retains them until they are changed or power is turned off.

Syntax: ~SetPump(MG, P1, P2, P3);~

Where: MG = MED-PC Global Pointer

P1 = The Pump Node Value (1 to 16)

P2 = The Rate (0.5 to 20 RPM)

P3 = The Infusion Time (0.1 to 99.9 seconds)

Comments: P_1 through P_3 may be numbers, constants, special identifiers, or variables. Note: Array elements must be expressed using square brackets P[1], not the normal parenthesis ( ) used in MEDSTATE NOTATION.

OnPump

The ONPUMP command selects the pump node and turns that pump on. It is not necessary to issue a SETPUMP command each time the pump is turned on. Allow at least one clock tick between the SETPUMP command and the ONPUMP command; i.e., do not place both commands in the same State.

Syntax: ~OnPump(MG, P1);~

Where: MG = MED-PC Global Pointer

P1 = The Pump Node Value (1 to 16)

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Comments: P_1 may be a number, constant, special identifier, or variable. Note: Array elements must be expressed using square brackets P[1], not the normal parenthesis ( ) used in MEDSTATE NOTATION.

LockOnPump

The LockOnPump command selects the pump node and locks on the pump until a LockOffPump command is sent.

Syntax: ~LockOnPump(MG, P1);~

Where: MG = MED-PC Global Pointer
P1 = The Pump Node Value (1 to 16)

Comments: P_1 may be a number, constant, special identifier, or variable. Note: Array elements must be expressed using square brackets P[1], not the normal parenthesis ( ) used in MEDSTATE NOTATION.

LockOffPump

The LockOffPump command selects the pump node and turns off the pump. It can even turn off the pump when it was turned on with the PumpOn command.

Syntax: ~LockOffPump(MG, P1);~

Where: MG = MED-PC Global Pointer
P1 = The Pump Node Value (1 to 16)

Comments: P_1 may be a number, constant, special identifier, or variable. Note: Array elements must be expressed using square brackets P[1], not the normal parenthesis ( ) used in MEDSTATE NOTATION.

MedState Notation Examples

The following two examples are functionally equivalent. A five second infusion at 3.33 RPM is used as the reinforcer for an FR-10 schedule.

Example A:

```
S.S.1,
S1,
  0.01": ~SETPUMP(MG, BOX, 3.33, 5);~ ---> S2

S2,
  10#R1: ~ONPUMP(MG, BOX);~ ---> S2
```

Example B:

```
LIST P = 0, 3.33, 5

S.S.1,
S1,
  0.01": SET P(0) = BOX;
         ~SETPUMP(MG, P[0], P[1], P[2]);~ ---> S2

S2,
  10#R1: ~ONPUMP(MG, P[0]);~ ---> S2
```


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MED-PC Log Errors

If a pump parameter is improperly specified or a pump is not responding, MED-PC will flag the error in the log files. The following list describes the errors and how to correct them:

Error	Cause	Correction
[1] Pump is not responding	The pump specified by SETPUMP did not return the proper checksum within the time required.	Check that a pump with that number exists in the system. Verify that the unit's power is on. Check all network cabling. Refer to page 1 for electrical connection information. Try operating the unit using the MED Test program. Call MED Associates for assistance if necessary.
[2] Rate must be between 0.5 and 20 RPM	Rate is not set within the allowable range.	Verify that the proper rates are used. Refer to the Controlling the Pump Using Custom MED-State Notation section of this manual.
[3] Duration must be 0.1 to 99.9 seconds.	Duration is not set within the allowable range.	Verify that the proper durations are used. Refer to the Controlling the Pump Using Custom MED-State Notation section of this manual.
[4] Pump halted due to errors	ONPUMP command not allowed due to errors in a previous SETPUMP command.	Check the log for previous errors and refer to the listings above for explanations.

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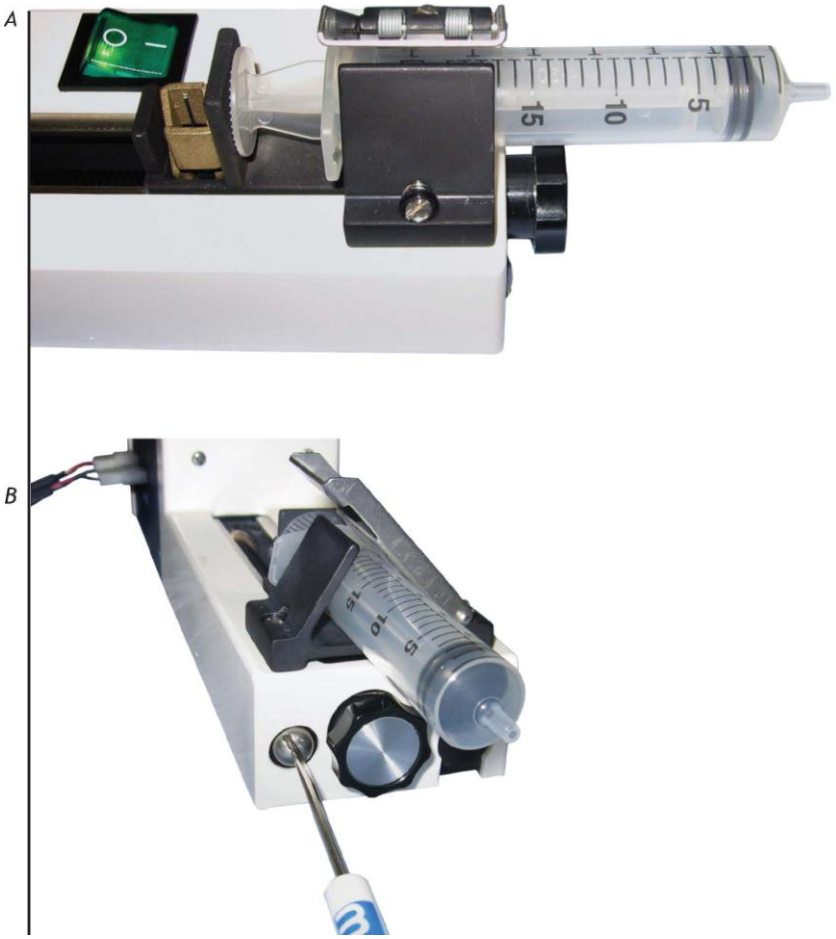
CHAPTER 5 | AUTOMATIC SHUT-OFF SWITCH ADJUSTMENT

The automatic shut-off switch is activated when the pump reaches the end of the syringe, causing the pump motor to cease operation. The automatic shut-off switch uses an internal micro-switch that detects when the slide assembly reaches a certain point. This point is adjustable so that the pump can accommodate various sizes and brands of syringes.

To adjust the automatic shut-off switch, insert an empty syringe with the plunger at the desired shut-off position. Move the slide assembly to the rear of the plunger (Figure 5-1A). With the pump turned on, switch the Flush switch on and rotate the adjustment screw (Figure 5-1B) until the pump stops operating. Turning the screw clockwise will allow the pump to operate longer before the automatic shut-off switch activates. Conversely, turning the screw counterclockwise will cause the automatic shut-off switch to activate sooner. In order to reset this switch and resume pump operation the slider must be moved back until the Automatic Shut-Off Switch is deactivated.

Figure 5-1 – Automatic Shut-Off Switch Adjustment



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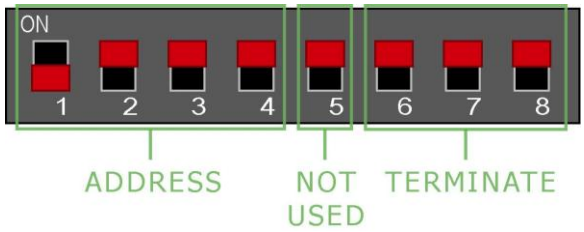
APPENDIX A | PHM-100VSS ADDRESSING SCHEME

The PHM-100VSS pump address settings should only be modified if a new pump is being added to an existing network. If the pumps have been purchased from MED Associates as part of a package or system, the addresses have been factory set and there is no need to adjust these settings.

To change the address or termination settings of a PHM-100VSS pump, remove the two recessed screws from the bottom panel of the unit.

There is an 8-position dipswitch that resembles Figure 5-2.

Figure 5-2 - PHM-100VSS Dipswitch



Switches 1 through 4 are used for setting the pump's address according to Table 5.1. Switches 6, 7, and 8 are used for differential line terminations, which are preset at the factory. Do not change unless adding additional pumps to the configuration. Only the last pump in the series should have switches 6, 7, and 8 set to ON. All other pumps should have these switches set to OFF. Switch 5 is not used.

In Figure 5-2 the pump address is set to 1 and since the terminate switches are all ON, it is the last pump in the series.

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Table 5.1 - Address Switch Positions

Pump Address	Switch Number			
	1	2	3	4
1	OFF	ON	ON	ON
2	ON	OFF	ON	ON
3	OFF	OFF	ON	ON
4	ON	ON	OFF	ON
5	OFF	ON	OFF	ON
6	ON	OFF	OFF	ON
7	OFF	OFF	OFF	ON
8	ON	ON	ON	OFF
9	OFF	ON	ON	OFF
10	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF
12	ON	ON	OFF	OFF
13	OFF	ON	OFF	OFF
14	ON	OFF	OFF	OFF
15	OFF	OFF	OFF	OFF
16	ON	ON	ON	ON

APPENDIX B | CONTACT INFORMATION

Please contact MED Associates, Inc. for information regarding any of our products.

Visit our website at www.med-associates.com for contact information.

For technical questions, email support@med-associates.com.

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